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where the cells have been derived from two different species, the specific characters of the cells remain distinct.

G. H. P.

Note. — No. 3 of Vol. XV of the *Journal of Morphology* contains: "Studies on the Maturation, Fertilization, and Cleavage of Thalassema and Zirphæa," by B. B. Griffin; "On the Blood-Plates of the Human Blood, with Notes on the Erythrocytes of Amphiuma and Necturus," by G. Eisen; "The Phosphorescent Organs in the Toadfish, Porichthys notatus Girard," by C. W. Green; "On the Species Clinostomum heterostomum," by W. G. MacCallum; and "Mitosis in Noctiluca miliaris and its Bearing on the Nuclear Relations of the Protozoa and Metazoa," by G. N. Calkins.

GEOLOGY.

The Absaroka Range of the Rocky Mountains. — In a presidential address before the Geological Society of Washington,[1] and in the Absaroka Folio of the United States Geological Survey,[2] Mr. Arnold Hague has presented the results of many years' field work in a region that contains for vulcanologists problems of extraordinary interest. The Absaroka Range forms the mountain barrier to the east of the Yellowstone plateau, and is composed chiefly of horizontally stratified volcanic flows and breccias thrown out from vents, the location of which is not marked by conical volcanoes or even by any positive trace which would show that such volcanoes existed. Thicknesses from two thousand to five thousand feet of these lavas are deeply trenched by streams draining the eastern face of a range which marks in a sense the eastern escarpment of the great plateau that forms the Yellowstone Park. Early breccia and basalt sheets overlaid by late breccias and basalts make up the mass of these lavas. The only interruptions to their horizontal continuity are massive bodies of intrusive rock that invaded the lavas at two distinct periods.

Evidence of the age of the lavas is derived from the contained plant remains and from the old topographies which underlie them. The accumulation of volcanic material rests unconformably on rocks ranging from archæan to cretaceous, and is confined within ancient orogenic barriers on the north and south. Evidence of erosion during the piling up of the eruptive material is shown by canyon cross-sections, which give evidence of old depressions filled with silts and gravels; this indicates that considerable erosion took place at different times, with long interruptions in the local volcanic activity. Over one hundred and fifty species of plants have been identified from the tuffs and breccias, indicating a range in age from eocene to upper miocene. They are thus geologically older than the neocene rhyolites that form the greater portion of the Yellowstone Park.

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[1] Hague, Arnold. Early Tertiary Volcanoes of the Absaroka Range.

[2] Folio No. 52, *Geologic Atlas of the United States*, Crandall and Ishawooa Quadrangles. Washington, 1899.

The intrusive bodies occur as stocks and dikes; an earlier group, the "Sunlight" intrusives, is characterized by orthoclase and augite, and cuts the earlier breccias and basalts. The "Ishawooa" intrusives have broken into the later basalts as well as the earlier and are more siliceous rocks, ranging from diorite and diorite porphyry to true granitic types. Dikes are associated with all the larger bodies, sometimes being offshoots from them, in other cases cutting them or cut by them, and presenting a marvelous variety of structural and lithological types that afford material for the study of extensive gradation between coarse crystalline and glassy volcanic rocks. Many of the dikes of the Sunlight group are orthoclase basalts, collectively called by the name "absarokite," and are related to coarser monzonite stocks, which range in composition from quartzose augite syenites to coarse gabbros and diorites. These older intrusive bodies occur in three principal masses that form the points of a triangle, and about two of them the dikes show remarkable radiation. The Ishawooa intrusives extend for a distance of fifty miles into the Yellowstone Park, occurring as stocks, sheets, and dikes; they are usually conspicuous about the head waters of the eastern flowing streams, but do not form culminating summits, these being usually composed of the breccias or late basalts which overlie the intrusive rock. Dikes here, too, are abundant, but radiation is not especially marked, the greater masses having rather an axial trend in a northwesterly direction, as though injected through a common fissure, rather than as forming independent intrusions. The breccias in contact with the greater intrusive bodies are indurated to a distance sometimes of more than one-half mile. Coarse granites and diorites occur in both the intrusive series — a remarkable fact when we consider that the lavas invaded by them are of Tertiary age.

Mr. Hague concludes that variation in coarseness of crystallization is not dependent upon pressure, but is far more affected by the rate of cooling. He agrees with Professor Iddings in the belief that, for the same stock and its complex of dikes, variations in composition and structure are due to varying conditions of crystallization from a single molten magma. Hague, however, differs from Iddings in his conception of the significance of the apparent radiation of dikes about the diorite and monzonite stocks of the Crandall quadrangle; Iddings believes this radiation to indicate that the central mass represented the root of a great conical volcano now eroded away, which he reconstructed to a height of ten thousand feet above the plateau at its present level. Mr. Hague fails to find any evidence of the building up of great volcanic piles, but compares the region to Iceland, where there are many centers of eruption and fissures through which the lava breaks forth, old sources of eruption in time becoming obliterated by fresh flows from newer vents.

The geologic maps of the Absaroka Folio show in very striking fashion the horizontal character of the flows and breccias where the digitate drainage intersects adjacent formations. The most conspicuous features shown by the map are the regular trend of the main divide on the southwest, parallel to the Ishawooa intrusive bodies, and the wonderful abruptness of the eastern gorges in contrast with the gentle slope of the streams which flow down to the high basin of Yellowstone Lake on the west. A conspicuous feature of the physiography is the remarkable curve from west to east of the head of North Fork Stinkingwater River, its head-water trend conforming exactly to the trend of Sunlight Creek, across the high divide formed by intrusive bodies in the Sunlight mining region. The Absaroka folio is illustrated by reproductions from photographs showing the deep canyon of Clark Fork cut in archæan granite, Index Peak composed of breccias overlying palæozoic limestone above archæan rocks, other pictures of dikes and breccias, and a view of Sunlight Glacier, one of the small remnants of the great glaciers that formerly played an important part in the erosion of the plateau.

The geological history of the region is briefly as follows. Palæozoic and mesozoic sediments were deposited throughout a long period to a thickness of many thousand feet, and at the close of Laramie time, mountain-building took place, producing uplift and deformation that was contemporaneous in all the ranges of the northern Rocky Mountains. This post-Laramie movement produced mountain ranges and plateaus which were considerably eroded before the first volcanic eruptions. These eruptions throughout Tertiary time are conceived to have had their manifestation by a variety of processes, in part building up volcanic cones, in part ejecting fluid lavas through fissures, and in part hurling out from vents which have left but few traces enormous masses of brecciated volcanic rock in a fashion that is without parallel in any region of active volcanoes. This great accumulation of surface lavas was later invaded by igneous magmas believed to be the elevated portions of a great complex of deep-seated crystalline rock; "where the underlying molten magma was subject to the severest pressure, the material was squeezed upward to higher levels following lines of least resistance, and consolidated at greater or less depths beneath the surface. . . . The line of Ishawooa intrusives marks the trend of one such upward movement of molten magma, which for the most part congealed without finding egress to the surface."

The two most remarkable features of Mr. Hague's observations in the Absaroka volcanic district are the enormous mass of breccias and the Tertiary granites and diorites. The explanation of the origin of the former as from divers vents along fissures and the demonstration of the coarsely crystalline character of the intrusive stocks add new evidence to dispel the time-honored but erroneous notion that great cones like Ætna or Vesuvius are essential features of great volcanic activity, and that granite is necessarily a very ancient rock. The Tarawera eruption of New Zealand and the fissure eruptions of Iceland show that the cone is an incidental product of eruption, not an essential. Geikie has brought forward, in his *Ancient Volcanoes of Great Britain*, much evidence to show that similar fissure eruptions were the prevailing type that produced the Tertiary basalt plateaus, and he too describes coarse granitic rocks of Tertiary age. The chief point of difference in the Absaroka Range is in the *brecciated* character of the horizontal lavas; the brecciated fragments are of all shapes and sizes and of great variation in kind, but nearly always volcanic. How did these breccias first crystallize as andesites or basalts in what were presumably continuous bodies of some sort, and later become broken up? This is a problem that has long puzzled the Yellowstone geologists, and for its complete solution an extended study and comparison of similar tuffs and breccias throughout the Cordilleran district will probably be required.

T. A. JAGGAR, JR.